THE STRUCTURE AND BIOLOGY OF THE RED SPIDER PREDATOR, "HYPOASPIS" MACROPILIS (BANKS)[1]

(ACARINA, LÆLAPTIDÆ)

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Populations of red spider predators almost always include one or more species of mites belonging to the group Mesostigmata. Although some of the beneficial species of the group are a familiar sight to field entomologists, comparatively little is known about the biology and taxonomy of the American species. Certain of them inhabit living foliage and prey upon red spiders, other destructive mites and small insects during summer whereas others, commonly found only among fallen leaves or in mulch, may be found to perform equally valuable services to agriculture by taking a toll of noxious pests in their winter hiding places.

Our experience indicates that several species of the mesostigmatic mites are apt to appear among red spiders infesting a given host, either concomitantly or in succession, and that some of the species are of greater importance than others in respect to biological control of red spiders.

The species described in this paper was observed to have played an important part in controlling a heavy infestation of the two-spotted mite, *Tetranychus bimaculatus* Harvey, in a large acreage of strawberries in Santa Cruz County, California.

Although originally described from water hyacinth, at Eustis, Florida, by Banks, "*Hypoaspis*" *macropilis*[2] was first listed as an important enemy of red spiders by McGregor (1917). His records show that the beneficial effect of this species against red spiders on sweet peas was twice noted by J. D. Mitchell at Victoria, Texas, and on badly infested chinaberry leaves in Orlando, Florida, by W. W. Yothers. Dr. Carl Huffaker, Division of Biological Control, University of California, recently submitted specimens of this mite which he found to be working on an infestation of *T. bimaculatus* on beans at Berkeley during January, 1949. Specimens in the U. S. National Museum collection have also been collected on miscellaneous plants in Cuba, Puerto Rico and Hawaii.

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[1] "*Hypoaspis*" *macropilis* (Banks) is not a true *Hypoaspis* but belongs to a genus close to *Amblyseius*, subfamily Phytoseiinæ. Until this group is revised the present generic placement of this species, although unsatisfactory, is being retained.

[2] The courtesy of Dr. E. W. Baker, U. S. Department of Agriculture, in identifying this mite is acknowledged with gratitude.

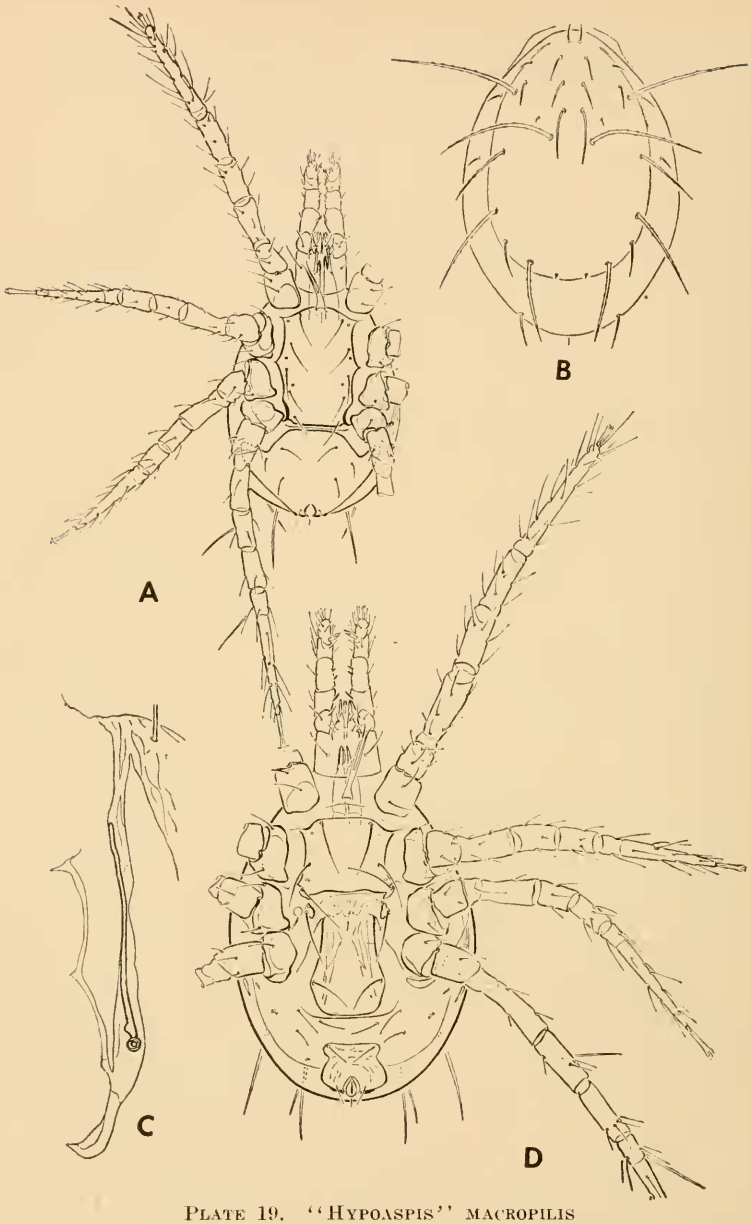

PLATE 19. "HYPOASPIS" MACROPILIS

A, Ventral aspect of male (X 100). B, Dorsum of female showing the dorsal plate and arrangement of setæ. C, Stigma, peritreme and associated plates illustrated from a laterally compressed female (X 190). The peritremal and dorsal plates are confluent anteriorly; only a part of the latter is illustrated. D, Ventral aspect of a mature female (X 100).

Insofar as the original description omits mention of certain features necessary for differentiating "*H.*" *macropilis* from related species described subsequently, a re-description is given.

"Hypoaspis" macropilis (Banks)

1905. *Lælaps macropilis* Banks. Proc. Ent. Soc. Wash., 7:139.

1915. *Hypoaspis macropilis* (Banks). Banks, U. S. Dept. Agr. Rept. 108, p. 86, fig. 169.

ADULT CHARACTERS

Female.— Body outline almost oval, slightly broader in posterior third. Dorsum irregularly roughened, depressed or flattened in young adults, vaulted or semi-globate in older or gravid forms; incompletely covered by a single chitinous plate. Fourteen pairs of unequally long setæ situated on dorsal plate; 3 additional pairs on periphery of body, independent of chitinous armature—2 pairs of scapular setæ, 1 pair terminal (caudal) setæ. Five pairs of dorsal setæ conspicuously elongate and faintly plumose (Pl. 19, B). Sternal plate approximately as long as wide, fitted between coxæ II; with 3 pairs of moderately long setæ and 2 pairs of pores. One pair of small metasternal plates behind sternal, each with one seta; an integumentary pore occurs on or near each metasternal. Genital plate irregularly hexagonal, longer than its greatest width in posterior third. A faintly visible semicircular flap of integument, the epigynium, projects anteriorly from front margin of genital plate to cover area between metasternalia; delicate strands of chitin spread fan-wise into epigynium from apical area of genital plate. Striated integument deeply folded in a transverse groove immediately behind genital plate. Two pairs of small parapodal plates in lateral wall above and behind coxæ IV. Small anal plate roughly shield-shaped, bluntly pointed behind anus; its lateral margins straight, excavate or often deeply incised; it bears a terminal pad of shagreen-like denticles on its hinder tip and 1 pair of setæ in addition to 2 paranals and postanal. All plates weakly sclerotized and variously traversed by fine cleavage lines, giving a mosaic-like pattern. One pair of coxal glands ("annulated tubes") in female only; saeculus spherical, thin-walled except for sclerotic area around junction with duct; the latter relatively short, its basal third distended or spindle-shaped, without annulations (Pl. 20, I); distal end terminates on or near articular folds of integument between coxæ III and IV. Epistome (tectum) delicately membraneous, its free margin even, slightly convex. External maxillary cornicles sharply pointed and narrow basally. A shallow groove along mid-ventral line of gnathosoma arises between bases of external maxillary cornicles and terminates near junction of gnathosoma and body proper; 8 transverse folds, each fringed with exceedingly small, anteriorly pointed spikelets, bridge the groove at almost regular intervals along its length. Moveable digit of chelicera with 3 small, simple, cusp-like teeth distributed along dental margin, and a sharply curved incisor or tip. Dental

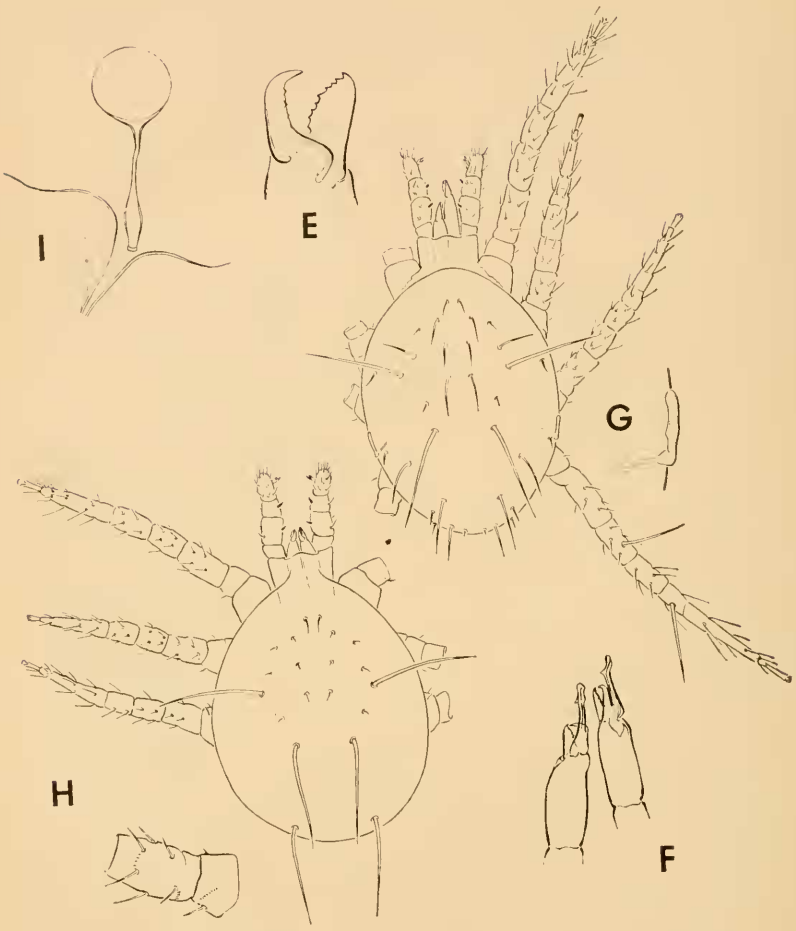

PLATE 20. "HYPOASPIS" MACROPILIS

E, Tip of chelicera in female (X 600). F, Male cheliceræ seen from below (X 240). The left one in the drawing is somewhat rotated from the normal position. G, Dorsal view of protonymph (X 110), including an enlarged sketch of its peritreme bulging the lateral body wall. H, Dorsal view of larva (X 110). The trochanter and femur of leg II are separately illustrated at greater magnification to illustrate the rows of minute spikelets described in the text. I, Schematic representation of one of the two coxal glands of female showing the termination of its duct between coxæ III and IV.

margin of fixed digit convex, with 9-10 saw-like teeth (Pl. 20, E). Peritremata terminate behind coxæ I. Posterior lobes of peritremal plates sickle-shaped, hooked and pointed at mesial ends. All legs longer than body; legs I and IV subequal and longer than legs II and III; all tarsi with short pedicels, adhesive folds and paired claws. Patella and tarsus (proximal tarsomere) of leg IV each with 1 long, plumose bristle. Color variable according to age. Recently moulted adults light brown with a milky area covering posterior quarter; robust or gravid individuals deep reddish brown or mahogany, with milky area restricted to anal region.

Male.—Smaller than female and slightly truncate posteriorly; otherwise body and appendages similarly proportioned. Dorsal vestiture as in female. Ventral plates (Pl. 19, A) comprising an elongate sternal-metasternal-genital plate accommodated between the coxæ, and an extensive anal plate having winglike lobes projecting behind coxæ IV. Anterior plate flanged on margins adjacent to coxæ IV; 5 pairs of setæ and 3 pairs of pores along its lateral margins. Anal plate with 3 pairs of setæ (occasionally 3½ or 4 pairs) in addition to 2 paranals and 1 postanal. Chelicera with slender, terminally forked spermatophore carrier adjoining lower digit (Pl. 20, F). Color as in female.

Measurements—Major dimensions are listed below in millimeters. Each is an average based on 5 or more mature specimens mounted in Berlese fluid.

	Body		Legs (over all)			
	Length	Width	I	II	III	IV
Male	0.26	0.20	0.36	0.28	0.31	0.40
Female	0.34	0.24	0.48	0.39	0.41	0.57

Remarks.—According to the nomenclature applied to several genera in the Phytoseiinæ by Garman (1948), the setæ of the dorsum and sidewalls may be grouped into paired *dorsal*, *median*, *lateral* and *scapular* rows. The setæ of *H. macropilis* are similarly distributed. The number comprising each row is: 6 *dorsal*, 1 *median*, 7 *lateral* and 2 *scapular*. There is also a *terminal* (or caudal) pair of setæ. Of the individual pairs, *d*5, *l*3, *l*4, *l*5, and *l*7 are conspicuous because of their great length; *m*1 and *d*6 are unusually short.

This mite may be transitional between forms having one and forms having two metasternal plates in the female as already described for *Typhlodromus reticulatus* by Oudemans (1930). The third pair of sternal setæ arise from small, rounded areas projecting from the postero-lateral angles of the female sternal plate. In occasional specimens, one or the other of the two areas appears to be separated from the sternal plate proper by a cleavage line.

The number of spikelets fringing the 8 transverse folds in the ventral groove of the gnathosome were determined in one

favorably mounted specimen. There were 4, 3, 4, 5, 3, 5, 4 and 3 spikelets in rows of 1 to 8 respectively as numbered from anterior to posterior.

IMMATURE STAGES

Egg.—Elongate spheriod, ca. 0.23 x 0.19 mm. Shell membrane entire, without surface peculiarities. Translucent; colorless, milky or amber.

Larva.—Hexapod. Peritreme and chitinous body plates not discernable in Berlese preparations. Ten pairs of unequally dorsal setæ (Pl. 20, H) are believed to comprise *dorsals* 1-5 inclusive, *laterals* 1-4 inclusive and *median* 1. Three pairs (*d5*, *l3*, *l4*) are conspicuously long and delicately plumose. Ventral setæ 13 in number: 3 pairs between coxæ, 2 pairs in pre-anal region, 2 paranals and 1 post-anal. A row of closely-set, minute, tooth-like spikelets, about 12 in number, curves obliquely across the postero-dorsal surface of each trochanter I. A similarly situated row of spikelets occurs on each trochanter II (Pl. 20, H). Femur of leg II also armed with minute spikelets arranged in 2 rows: one postero-dorsal row of 4 or 5 spikelets near proximal end; a second row of 4 outwardly projecting spikelets occurs on the dorsal surface between the 2 regular setæ near distal end. Only one stubby or frayed seta present on mesial surface of fourth segment (patella) of palpus. Absent are the ventral setæ or maxillary coxæ and 1 of the 3 pairs of setæ on the bases of the maxillary cornicles.

Remarks.—The minute spikelets on the podomeres of legs I and II are limited to the larval stage. Whether or not they occur in the larvæ of other species is not known at present. The pair of long, terminal setæ of the larval phase appear to be incorporated in the definitive *lateral* row, as *l4*, when new setæ develop behind during the first moult. The setæ designated as *median* 1 are in line with the row of laterals at this stage. They are displaced towards the mid-line in the deutonymph.

Protonymph.—Similar to larva in respect to size but with posterior body outline less broadly rounded and having 4 pairs of legs instead of 3. Short rudimentary peritremata appear beneath integument above fourth pair of legs. Full complement of dorsal setæ, 17 pairs, are present at this stage (Pl. 20, G), but those added during ecdysis remain comparatively small and clustered at the posterior end. An additional pair of setæ appears on ventral body surface, in the pre-anal region. The protonymph thus has 3 pairs between the coxæ of the legs, 3 pairs in the pre-anal region and 2 setæ adjacent to the anus. One pair of setæ below on maxillary coxæ and 3 pairs on hypostome are present in this instar. Fourth segment of palpus with one stubby seta on mesial surface, as in the larva. Transverse folds fringed with minute spikelets occur at intervals along ventral groove of gnathosoma. Patella and tarsus of leg IV each with 1 conspicuously long seta.

Deutonymph.—Size and color intergrading between photonymph and

adult. Chætotaxy as in adult. Peritremata extend forward to approximate middle of coxæ II. Two stubby setæ on mesial surface of fourth segment of palpus.

Remarks.—It is known that mites in this stage feed more extensively and show a greater rate of gain in size than during previous instars. Reliable anatomical criteria for distinguishing late deutonymphs from young adults could not be established in the procedures employed, consequently the number of moults in the development of male and female lines is not known to deviate from the pattern established for lælaptid mites in general. Mature males copulate with females resembling deutonymphs. The newly mated females are smaller than the old or gravid females, they are light brown in color and have an extensive milky area behind. The dorsum is weakly vaulted. In mature females the skeletal parts become more heavily chitinized, the body distends, and the color deepens to a deep brown or mahogany color. Individuals of this appearance comprised less than 5 percent of the field population examined in mid-June.

Life History

This predatory mite was collected in large numbers from a field of strawberries at Watsonville, California, on June 11, 1948. The extent of leaf damage, webbing, egg shells, etc., indicated that a heavy population of the two-spotted mite, *Tetranychus bimaculatus* Harvey had been present earlier. Many plants were severely dwarfed as a result. The predatory mites were present on every damaged leaflet examined, but only occasional colonies of the red spiders remained. The predatory mites were concentrated among the remaining red spider colonies, so that 20 to 30 of the predaceous forms were often found on each leaflet infested.

Infested strawberry leaves were collected in glass jars and stored at 42°F until needed. Life history studies were conducted by isolating one or more predatory mites in homeopathic vials stoppered with corks (MacGill, 1939). Tetranychid mites, either *T. bimaculatus* of *T. pacificus*, were introduced into the vials on pieces of leaf, to serve as food. The vials were held at room temperature. The latter usually rose to about 85°F in the afternoon. Moisture from the pieces of leaf frequently condensed as droplets on the inner walls of the vials. The amount was often sufficient to entrap the tetranychids yet the predaceous forms were not inconvenienced by it. This hydrophilic tendency is interesting since the species was first described from water hyacinth.

The predatory mites, both males and females, were seen feeding on all stages of red spiders, although the eggs and

motionless moulting stages seem to be preferred. A red spider egg is consumed in about 45 seconds and only the wet, crumpled shell is discarded. The larger stages of red spiders are not completely consumed. Starved individuals may feed on one another or on their own eggs. While feeding, the mites hold the anterior pair of legs high in the air, almost perpendicular to the body axis.

The predators were fed *T. bimaculatus* or *T. pacificus* on pieces of leaves of pansy, potato, columbine and morning glory. All of these were acceptable to the predators. However, they could not survive in vials containing pacific mites on grape leaf. Apparently the grape foliage or the pacific mites thereon are toxic to this predator.

These mites are agile and rapid runners, yet they often spend 24 hours or more alternately resting and slowly moving about within an area not larger than a few millimeters in diameter. If disturbed, they leave the area and run rapidly over the leaf and vial for several minutes before coming to rest in another location.

Lælaptid mites in general are known to have two nymphal stages. This is apparently the case in "*H.*" *macropilis*. The succession of post-larval stages is difficult to follow in this species because the moulting process is quickly accomplished and the exuviæ are so delicate that they are most difficult to find on a leaf unless the moulting process is actually observed. No anatomical features, visible in life with a binocular microscope, could be found for distinguishing between late protonymphs and deutonymphs or between deutonymphs and young adults. Criteria of size and color were relied upon but were not definitive. Consequently, the best reference point for timing the life cycle was the deposition of the first egg by a female of known age. Using this criterion, the time elapsed between the end of the larval stage and the deposition of the first egg was found to vary from 3.0 to 4.9 days. As based on data compiled from 55 complete or partly completed individual case histories, the approximate duration of the several stages at room temperature was established as follows: egg—40 hours, larva—8 hours, combined nymphal stages—72 hours, total—5 days.

In copulation the male hangs upside down on the venter of the female and is carried about in this position. The male remains in this position for 35 to 45 minutes. One pair was seen to assume the copulatory position a second time, 6 hours after the first pairing. In every case where pairing was observed, the female laid 2 to 3 eggs within the first 24 hours after the separation. Aside from copulation, no differences were observed in the habits of males and females.

The eggs are usually attached by one end to the leaf surface, but they are sometimes laid in the web produced by the tetranychid mites. They are colorless or hyaline when first laid and pale to reddish amber prior to hatching. The eggs of the predator can be distinguished from those of the red spiders by their different shape and larger size.

The duration of the egg stage was not precisely determined because the vials were ordinarily examined but once a day. None of the eggs were observed to hatch earlier than 24 hours or later than 48 hours. A few eggs observed at closer intervals are known to have hatched within 35 to 45 hours.

The greatest number of eggs laid in one day by a female was 4. This occurred in several instances. Three eggs per day was fairly common but most of the mites laid only 2 eggs per day. One female produced a total of 9 eggs in 3 consecutive days.

The small, white larvæ are quiescent. They remain on the same spot where hatched or they may slowly move a few steps away from the shell. They are capable of running and may do so if disturbed. They have never been observed to feed and they do not appear to seek food. The length of this stage was found to be brief, always less than 24 hours. One larva moulted 6 hours after hatching.

Several females, isolated as nymphs, lived as adults for 6 to 25 days without ovipositing. The sex of these was verified post-mortem. In other cases isolated females laid no eggs until caged with males, whereupon oviposition started almost immediately. Adult life, as measured from copulation or first oviposition to death, varied from 18 to 34 days, with a mean of 29 days. Apparently the male is as long-lived as the female since one lived 33 days.

The manner in which the species overwinters is not known. Some light is shed on this point by the fact that adult and developmental stages were found on the leaves of beans growing out-of-doors at Berkeley on January 9, 1949. Specimens collected in June and stored on strawberry leaves at 42°F were immobilized at that temperature. After storage for 37 days about 95 per cent of the mites were dead and only a few were able to resume normal activities when removed to room temperature. Eggs stored at 42°F for 37 days did not hatch when incubated thereafter.

Discussion

The information presented in regard to the life history and habits of *Hypoaspis macropilis* represents only a step in the accumulation of the facts required to assess its potential value in controlling red spiders or perhaps other small organisms on

which it preys. Under summer laboratory conditions, probably far from ideal, its development is known to be rapid. The minimum cycle, egg to egg, requires approximately 5 days. The rapid development, coupled with an adult longevity of about 4 weeks and an oviposition rate of 2 or more eggs per day for an undetermined period, indicate that populations of this predator may build up more rapidly than those of the red spiders.

Until such time as the relations between this particular predator and its prey can be expressed in more quantitative terms, the evidence concerning its positive economic value remains inferential.

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A NEW SUBSPECIES OF STENELMIS FROM NEVADA

(COLEOPTERA, DRYOPIDÆ)

By IRA LA RIVERS, *University of Nevada, Reno*

Stenelmis calida moapa[1], new subspecies

General: A cylindrical beetle with reddish-brown dorsum, a yellow venter and greenish tinges on the legs. Dorsal color may be broken on elytra by two faint vittæ and darkening anteriorly on pronotum. Size: length 3.1-3.6 mm., width 1.0-1.2 mm.

Head: Round, compact, withdrawn beneath anterior margin of pronotum to posterior eye margins; surface minutely but distinctly tuberculate, tubercles distinctly darker than groundcolor; occiput and face (interocular space) pale (often with a greenish tint), with a distinct reddish vertical bar extending to clypeus; clypeus darker, blue-black, with a wide, distinct, silvery band across entire anterior edge (labroclypeal band) present in both male and female. Labrum similar in color to clypeus, generally darker, the dorsal (upper) border polished, shining black, conspicuous whitish pile rendering remainder more bluish-white;

[1]The following description is based entirely on material examined in alcohol. In dried specimens, the true color pattern is badly obscured by pile and a coating of bluish-white powder.